



LiveLEARNING WEBINARS™

LTE INTERFERENCE/UHF LEAKAGE

➕ May 20, 2015

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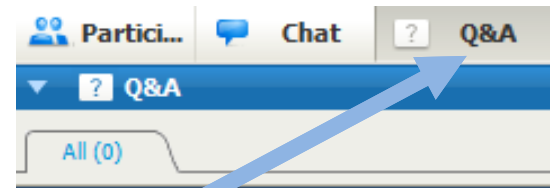
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TODAY'S SESSION

- Approximately 50 minutes discussion
- 10 minute Q&A at the end, however.....
 - Ask questions anytime throughout the session
 - Asking questions adds value and enhances learning opportunity for you and others

HOW TO ASK A QUESTION



- Select the “Q&A” tab
- Type in your question and submit

A screenshot of the question submission form. It features a text input field with the placeholder text 'Type a question here.'. Below the input field are two buttons: 'Send' and 'Send Privately...'. A blue arrow points from the second bullet point in the list above to the text input field.



LiveLEARNING WEBINARS™

NOW LET'S GET STARTED...

LTE INTERFERENCE/UHF LEAKAGE

May 20, 2015



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LiveLEARNING WEBINARS™



→ Ron Hranac

Technical Leader
Cisco Systems

- Chairman, Network Operations Subcommittee
- SCTE Hall of Fame Inductee
- Past SCTE Chairman of the Board and President

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➔ **Nick Segura**

*Director, Technical Operations
Charter Communications*

- SCTE Region 2 Representative
- SCTE Board of Directors
- SCTE Network Operations Subcommittee Working Group 1

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AGENDA

- ➔ Challenges of UHF leakage and LTE interference
- ➔ What's in the affected spectrum?
- ➔ The two-way street: Ingress and direct pickup
- ➔ What is field strength?
- ➔ Lack of VHF and UHF leakage correlation
- ➔ Some typical causes of UHF leakage, ingress and direct pickup
- ➔ What can be done?

POLL QUESTION

- ➔ Has your system been contacted by an LTE service provider about UHF leakage-related interference?
 - + Yes
 - + No

Respond to the survey in the window on the right and click "Submit"



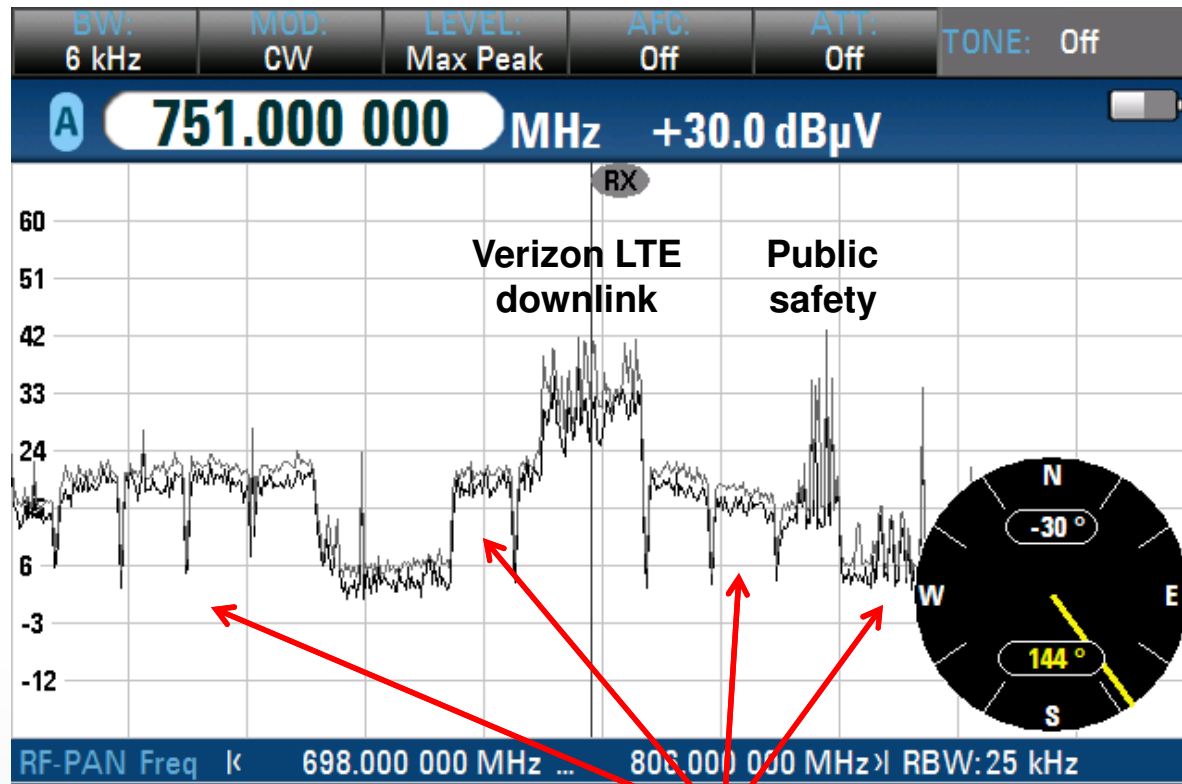
UHF leakage

Frequencies	Signal leakage limit (micro volt/meter)	Distance in meters (m)
Less than and including 54 MHz, and over 216 MHz	15	30
Over 54 up to and including 216 MHz	20	3

A more common problem than many believe

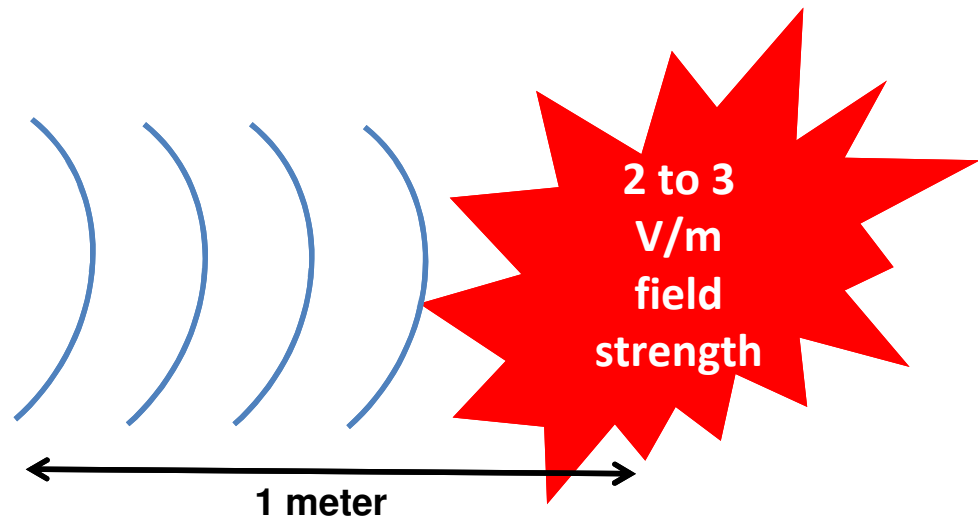
- ▶ The cable industry for decades has monitored leakage in or near the 108-137 MHz very high frequency (VHF) aeronautical band
- ▶ During the past few years cable operators have become aware of ultra high frequency (UHF) leakage, largely because of interference to long term evolution (LTE) services in the 698-806 MHz spectrum
- ▶ Existing leakage equipment doesn't work at UHF
 - The good news: commercial UHF leakage gear now available
- ▶ Limited industry experience dealing with UHF leakage

LTE interference: UHF leakage may overlap the LTE spectrum



Leaking QAM and other signals present in over-the-air spectrum

LTE interference: Ingress and direct pickup in the home



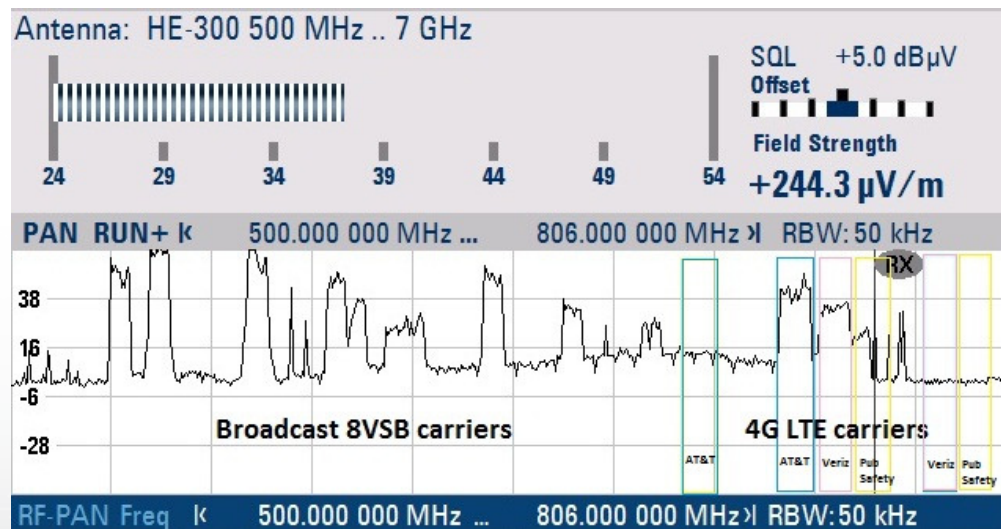
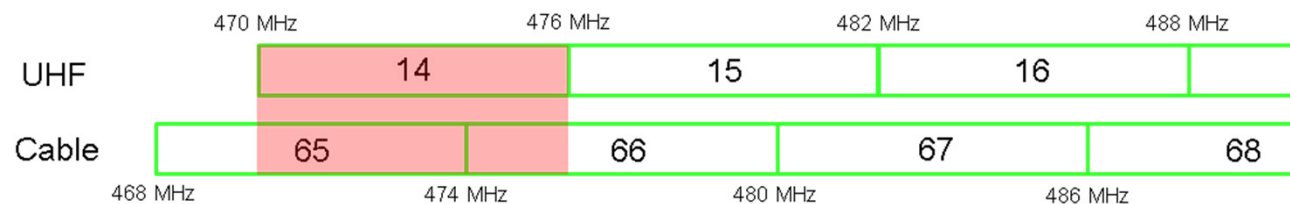
LTE user equipment (UE) transmitting at its maximum power of $+23 \text{ dBm} \pm 2 \text{ dB}$, can produce as much as $2,000,000 \mu\text{V/m}$ to $3,000,000 \mu\text{V/m}$ (2 V/m to 3 V/m) field strength 1 meter away.

The challenges

- ▶ Harmful interference to over-the-air users may occur
 - Leakage-related harmful interference MUST be fixed promptly per §76.613, regardless of field strength
 - May result in FCC enforcement action (\$\$)
 - Cases of safety of life and property may result in forced turn-off of signals until source of leakage repaired
- ▶ Ingress and direct pickup interference
 - Service degradation or disruption
 - Subscriber dissatisfaction
 - Impact on performance of new technologies such as DOCSIS® 3.1

What's in the affected spectrum?

Frequency reuse lets us share the spectrum



- 470-698 MHz:
UHF TV
- 698-806 MHz:
*LTE tower-to-UE,
LTE UE-to-tower,
public safety*
- 806-902 MHz:
*Cellular, trunked 800
MHz radios*

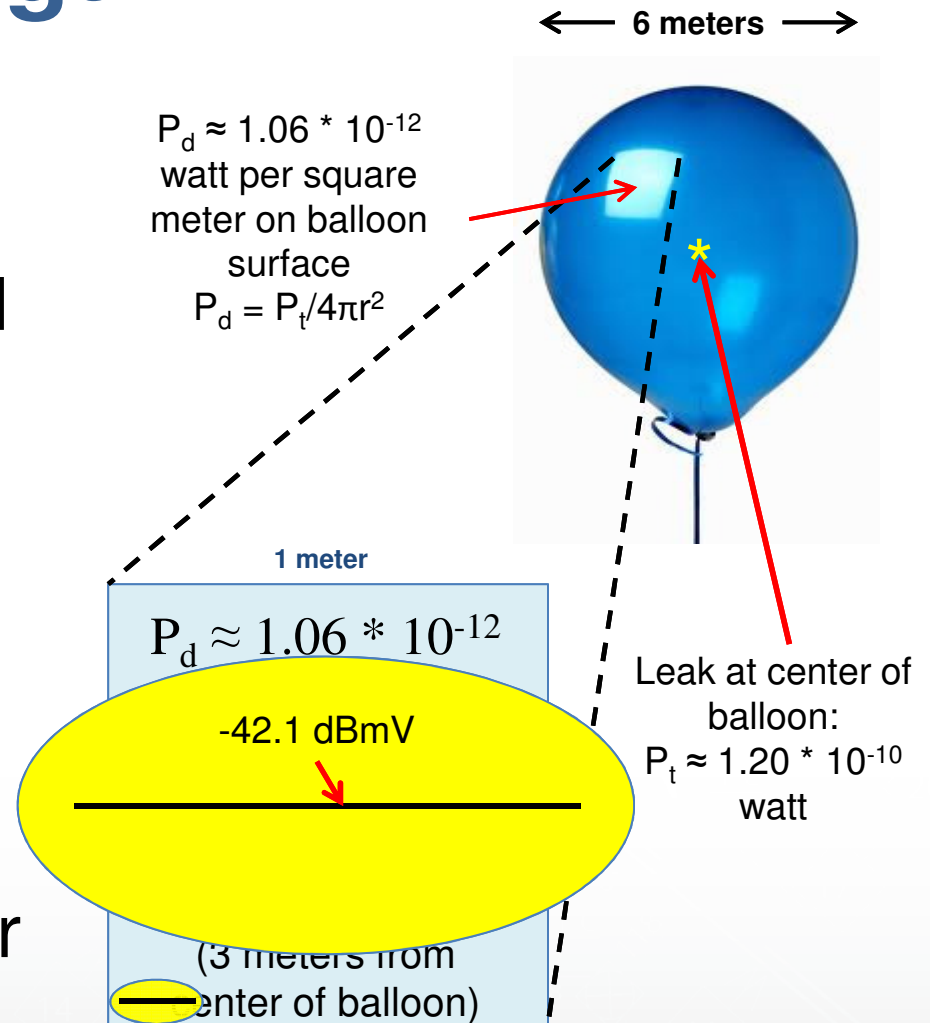
The two-way street

Leakage, ingress, direct pickup

- ▶ Leakage can interfere with over-the-air services
- ▶ Ingress from over-the-air signals can interfere with cable signals
 - Some cable operators have abandoned affected channels
- ▶ Direct pickup interference can affect customer premises equipment (CPE) and other devices
 - Older CPE usually more susceptible, newer CPE has better shielding. Poorly shielded retail-grade cables and components can offset the benefits of good CPE shielding.
 - Some headend equipment susceptible to direct pickup

What is field strength?

- ▶ Field strength is the RF power density (P_d) in a 1 meter x 1 meter square (in free space, in the air, on the surface of an imaginary balloon), expressed as a voltage – hence, the “volts per meter” or “microvolts per meter” designation.



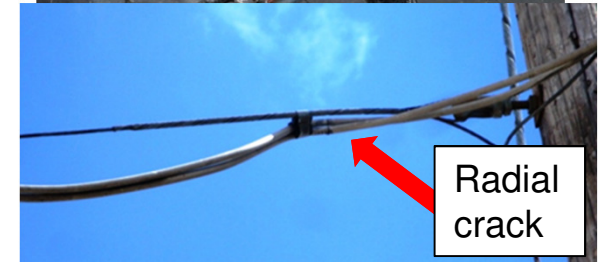
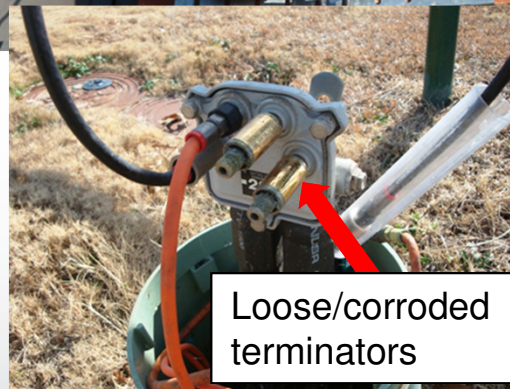
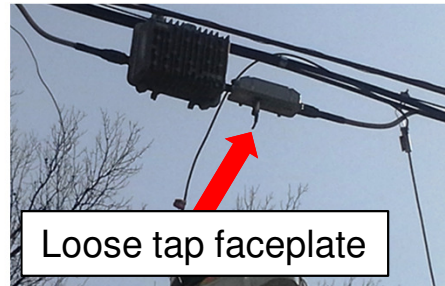
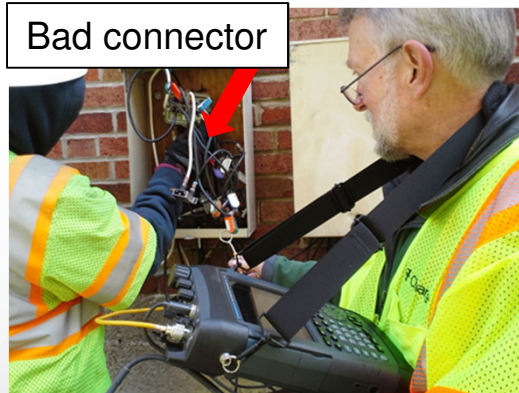
$$E_{\mu V/m} = \sqrt{([1.06103295 * 10^{-12} \text{ watt}] * 120\pi)}$$

Lack of VHF and UHF correlation

Tight plant at VHF? That's not enough!

- ▶ Field studies have shown there is little or no correlation between VHF and UHF leakage field strengths
- ▶ The plant might be tight in the VHF aeronautical band, but leakage can be significant at UHF
- ▶ Further complicating UHF leakage detection and measurement is the antenna factor difference between VHF and UHF antennas. This difference effectively reduces sensitivity at UHF.

UHF leakage mechanisms



LTE interference: Causes of in-home ingress



Source: "Cable Technicians of America" Facebook Community

LTE interference: Direct pickup in CPE



Older CPE usually more susceptible, newer CPE has better shielding. Poorly shielded retail-grade cables, splitters, etc., can offset the benefits of good CPE shielding.

What can be done?

LTE service provider relationships

- ▶ Respond immediately – do NOT delay
- ▶ Schedule techs ASAP
- ▶ There could be substantial UHF leakage even if there is no VHF leakage
- ▶ If UHF leakage detection gear is available, use it
- ▶ If you don't yet have UHF leakage gear, a home-brew combination of equipment might work for confirming the presence of UHF leakage
- ▶ Fix the problem
- ▶ Provide system point-of-contact info to LTE engineers
- ▶ Notify customer service reps to direct inquiries to appropriate person
- ▶ Document everything

What can be done?

Commercial solutions

- ▶ Several manufacturers now are shipping digital-compatible UHF leakage detection equipment
- ▶ You should be planning near-term implementation of a UHF leakage monitoring program
 - The FCC has already taken enforcement action against cable operators for UHF leakage $>15 \mu\text{V}/\text{m}$ at 30 meters, as well as for harmful interference to LTE services

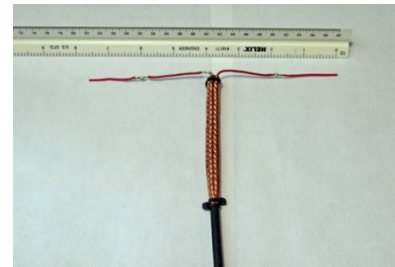
What can be done?

“Home-brew” combinations

- ▶ Possible short-term solution until commercial gear is obtained at system level
- ▶ Test results with home-brew solutions were mixed
- ▶ Certain combinations of spectrum analyzer, preamplifier, bandpass filter, and high-gain antenna can be used to at least confirm the *presence* of UHF leakage



LTE-compatible antennas



750 MHz dipole



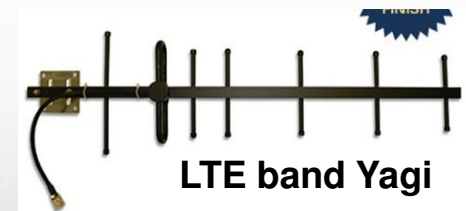
UHF TV antenna



Preamplifiers



Spectrum analyzer

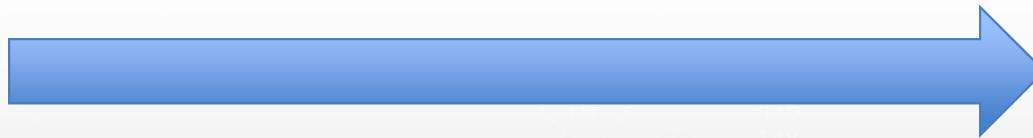


LTE band Yagi

POLL QUESTION

- ➔ How do you monitor for signal leakage in the 600 MHz to 800 MHz spectrum?
 - ⊕ New commercially manufactured UHF digital compatible leakage detector(s)
 - ⊕ Homebrew combination of test equipment
 - ⊕ We only monitor in or near the 108 MHz to 137 MHz aeronautical band

Respond to the survey in the window on the right and click "Submit"



Leakage mitigation

VHF *and* UHF leakage

- ▶ Finding and repairing leakage
- ▶ Preventing future leakage
- ▶ Best practice strategies used by technicians today
- ▶ Recommended best practice strategies going forward
 - SCTE recently published “Technical Report: UHF Leakage, Ingress, Direct Pickup” (SCTE 209 2015), available for download at http://www.scte.org/standards/Standards_Download_Page_3.aspx

From the field

- ➔ CW carrier “battle wounds”
- ➔ Getting inside of problem homes
- ➔ What’s in the over-the-air environment
- ➔ Setting up headend reference signals
- ➔ Reference (“calibrated”) leak
- ➔ Smart phones and similar devices

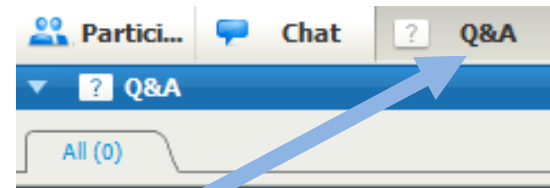


SUMMARY

The challenges are solvable

- ▶ UHF leakage, ingress, and direct pickup must be taken seriously NOW
- ▶ Significant risks and liabilities
- ▶ Approach from several directions:
 - Implement a UHF leakage program with your existing VHF leakage program
 - Avoid future leakage problems
 - Adopt best practice strategies for today and tomorrow

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THANK YOU TO OUR SPEAKERS



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